John A. Volpe National Transportation Systems Center
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Millwork West Site Improvements
Libby, Montana

# REVISION 1
# TECHNICAL SPECIFICATIONS

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Prepared By

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MILLWORK WEST
SITE IMPROVEMENTS

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 DEFINITIONS

A. Government - the government shall be defined as the Volpe National Transportation Systems Center (Volpe Center), Contracting Officer (CO) or Contracting Officer's Technical Representative (COTR).

B. Engineer - shall be defined as an authorized representative from the Volpe Center's Architect/ Engineering (A/E) firm.

C. Government's Removal Contractor - shall be the Government's removal contractor selected to perform the work and all of its subcontractors, suppliers and vendors.

1.02 LOCATION OF WORK

A. The work of this contract is located in the City of Libby, Montana. The two existing Millwork West Buildings are located on Highway 2.

1.03 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install asphalt paving in Building No. 1 and a reinforced concrete floor and restroom in Building No. 2 complete as shown on the Drawings and as specified herein.

B. The work is being performed as part of the U.S. EPA asbestos removal and restoration project in Libby, Montana.

C. The work includes providing underground electric service and City water service to a proposed restroom in Building No. 2 and a septic tank, submersible pump and discharge piping to an existing, permitted septic tank and leaching area also located on the property.

D. The Work includes, but is not necessarily limited to, the following:

1. Providing all excavation and backfilling for electric service, water service, septic tank, and sewage discharge piping.

2. Restoration of all trench surfaces to condition existing prior to excavation. Asphalt, concrete and gravel surfaces exist in the work area.

3. Subgrade preparation and installation of a asphalt pavement covering approximately 50% of the Building No. 1 floor area, full reinforced concrete floor in Building No. 2 and one restroom in Building No. 2.

4. All necessary electrical, HVAC, carpentry, painting, plumbing and all other work required to complete the work described on the Drawings and in the specifications.

E. These Drawings and accompanying specifications have been prepared for the Government's use in providing a general description of the work to be completed by the Government's removal contractor at Building No. 1 and Building No. 2 on Highway 2 in Libby, Montana.

F. The work described in the Drawings and specifications will be constructed in two wood frame metal clad buildings originally intended to serve as a temporary location for the Millwork West lumber and building materials business.

G. The work described on the Drawings and in the specifications is not intended to be publicly bid.

H. The Drawings and specifications are intended to be provided to the Government's removal contractor for cost estimates, construction scheduling, obtaining local subcontractors appropriately licensed to perform specialty construction (plumber, electrician, etc.), obtaining necessary local permits (restroom permit) and completing the work.

I. The Drawings and specifications are intended to provide a general description of the work to be performed. The Government's removal contractor is required to verify all dimensions prior to starting the work.

J. No property line or topographical surveys were available to reference for preparation of the Drawings.

K. No investigations have been made with respect to the current use or potential use of the existing buildings.

L. Evaluation of the existing buildings with respect to structural integrity, Building Code compliance, existing condition were not included in the design scope of work.

M. CDM's scope of work for existing Building No. 2 was limited to design of a reinforced concrete slab to be installed by the Government's removal contractor, design of a single unisex, handicapped accessible restroom meeting the requirements of the ANSI Accessibility Code, 1998 edition, restroom water service, restroom electric service and pumped discharge of all waste from the proposed restroom to an existing permitted septic tank located on the property approximately 300 ft. from Building No. 2.

N. CDM's scope of work for existing Building No. 1 was limited to design of asphalt pavement to be installed by the Government's removal contractor over approximately 50% of the interior floor area.

O. The Owners of Millwork West will be responsible for moving materials out of the work area prior to the Contractor beginning work. This shall be coordinated with Volpe, Millwork West and the Contractor. The Owners of Millwork West will put back all materials temporarily moved out of the work areas after the work has been completed, concrete and asphalt cured to required strength and approval received from the CO/COTR.

P. Provide up to 300 linear feet of 6-ft high temporary galvanized steel chain link fence and one 14-ft wide locking gate. Fencing shall be erected in the location determined by the Owners of

Millwork West and the Government to temporarily store materials removed from Building No. 2. Remove temporary fencing after the Owners of Millwork West have returned items to Building No. 2. Submit details for review by the CO/COTR.

1.04 WORK SEQUENCE

A. The Contractor shall coordinate the scheduling of all work with the CO/COTR and Owners of Millwork West. All work shall be completed in 2002.

B. Work in Building No. 1 and Building No. 2 shall not be performed simultaneously. Work will not begin in one building until all work is completed in the other building. Contractor shall coordinate order of work with the CO/COTR and Owners of Millwork West.

C. No work shall begin on Building No. 1 or Building No. 2 until work by others at the new Planer Building is complete.

D. Contractor shall conduct all work in a manner so as not to interfere with the daily operation of the Millwork West business.

1.05 CONTRACTOR'S USE OF PREMISES

A. Contractor shall coordinate use of the designated areas on the premises for the performance of the work with the CO/COTR and Owners of Millwork West. Utility companies shall also have complete access to the property for water and electric service.

B. Only areas approved by the CO/COTR and Owners of Millwork West shall be used for storage of materials, equipment, etc. Existing utilities, structures and stored materials owned by Millwork West shall not be entered upon or in any way disturbed by the Government's removal contractor and any of its' subcontractors in the performance of this work.

C. Contractor shall assume full responsibility for safety and security of all his/her and his/her subcontractors materials and equipment stored on the site.

D. If directed by the CO/COTR, move any stored items that interfere with operations of the Owners of Millwork West.

E. Obtain and pay for use of additional storage or work areas if needed to perform the Work.

1.05 OWNERS OF MILLWORK WEST OCCUPANCY

A. Owners of Millwork West will occupy the improved premises following completion of the work and approval from the CO/COTR for the conduct of normal business operations. Coordinate all construction operations with the CO/COTR and Owners of Millwork West to minimize conflict and to facilitate usage.

END OF SECTION

DIVISION 1 – GENERAL REQUIREMENTS

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of submissions applicable to Shop Drawings, Product Data, Samples, and Construction Schedules. Detailed submittal requirements are specified in the technical Sections.

B. All submittals shall be clearly identified by reference to Section Number, Paragraph, Drawing Number or Detail as applicable. Submittals shall be clear and legible and of sufficient size for presentation of data.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A. Shop Drawings

1. Shop drawings as specified in individual Sections include, custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work.

2. All shop drawings submitted by subcontractors shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.

3. Check all subcontractor's shop drawings regarding measurements, size of members, materials and details to make sure that they conform to the intent of the Drawings and related Sections. Return shop drawings found to be inaccurate or otherwise in error to the subcontractors for correction before submission thereof.

4. All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.

B. Product Data

1. Product data as specified in individual Sections include, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams

and templates, catalog cuts, product photographs, concrete mixes, sieve analyses, reinforcing bar placement details, Material Data Safety Sheets, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples

1. Samples specified in individual Sections include, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:

1. Field measurements

2. Field construction criteria

3. Catalog numbers and similar data

4. Conformance with related Sections

B. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package.

C. Notify the CO/COTR in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

D. The review and approval of shop drawings, samples or product data by the CO/COTR shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract.

E. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Government will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

F. Project work, materials, fabrication, and installation shall conform to approved shop drawings, applicable samples, and product data.

1.04 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Each submittal, appropriately coded, will be returned within 15 business days following receipt of submittal by the CO/COTR.

C. Number of submittals required:

1. Shop Drawings: five copies.

2. Product Data: Four copies.

3. Samples: Submit the number stated in the respective Sections.

D. Submittals shall contain:

1. The date of submission and the dates of any previous submissions.

2. The Project title and number.

3. Contractor identification.

4. The names of:

a. Contractor
b. Supplier
c. Manufacturer

5. Identification of the product, with the section number, page and paragraph(s).

6. Field dimensions, clearly identified as such.

7. Relation to adjacent or critical features of the work or materials.

8. Applicable standards, such as ASTM or Federal Standards numbers.

9. Identification of deviations from Contract Documents.

10. Identification of revisions on resubmittals.

1.05 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

A. The review of shop drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed as:

1. permitting any departure from the Contract requirements;

2. relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;

3. approving departures from details furnished by the COTR, except as otherwise provided herein.

B. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

C. Submittals will be returned to the Contractor under one of the following codes.

Code 1 - "APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 - "APPROVED AS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 - "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Codes 1 through 3 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

D. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made by the CO/COTR on the previous submission. Additionally, the Contractor shall direct specific attention to any revisions made other than the corrections requested by the CO/COTR on previous submissions.

E. Partial submittals may not be reviewed. The CO will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Not Approved" until resubmitted. The CO/COTR may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

F. When the shop drawings have been completed to the satisfaction of the CO/COTR, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the CO/COTR.

1.06 DISTRIBUTION

A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the CO/COTR. Number of copies shall be as directed by the CO/COTR but shall not exceed five.

1.07 GENERAL PROCEDURES FOR SUBMITTALS

A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING AND COMPACTION

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements.

B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein and shall provide suitable room for installing pipe, structures and appurtenances.

C. Notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays and Legal Holidays) before excavating in any public way. Also notify Montana U-Dig Telephone No. 1-800-551-8344 at least 72 hours prior to start of work.

D. Furnish and place all sheeting, bracing and supports and shall remove from the excavation all materials which the CO/COTR may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects, acceptable. If conditions warrant, deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. All excavation shall be made in open trenches.

E. All excavation, trenching and related sheeting, bracing, etc, shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and to all applicable Federal, State and local requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

F. Wherever the requirement for 92 percent compaction is referred to herein it shall mean "at least 92 percent of maximum density as determined by ASTM D1557, Method D".

G. Prior to the start of work submit the proposed method of backfilling and compaction to the CO/COTR for review.

### 1.02 RELATED WORK

A. Earthwork details are shown on the Drawings.

B. Concrete and reinforcing steel is included in Section 03301.

C. Electrical is included in Section 16020.

## PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. Trench excavation shall include material of every description and of whatever substance encountered, except rock and boulders. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.

B. Strip and stockpile topsoil from grassed areas crossed by trenches. At the Contractor's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.

C. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected as directed by the CO/COTR.

D. Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the CO/COTR. Trench width shall be practical minimum.

E. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by screened gravel fill as required by the CO/COTR at the Contractor's expense.

F. Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last 1-ft of depth.

G. Where pipe is to be laid in screened gravel bedding, the trench may be excavated by machinery to the normal depth of the pipe provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

H. Where pipe is to be laid directly on the trench bottom, final excavation at the bottom of the trench shall be performed manually, providing a flat-bottom true to grade upon undisturbed material. Bell holes shall be made as required.

3.02 DISPOSAL OF MATERIALS

A. Excavated material shall be stacked without excessive surcharge on the trench bank or obstructing free access to hydrants and gate valves. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.

B. It is expressly understood that no excavated material shall be removed from the site of the work or disposed of, except as directed by the CO/COTR. When removal of surplus materials has

been approved by the CO/COTR, dispose of such surplus material in approved designated areas.

C. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored at a location provided. When required, it shall be re-handled and used in backfilling the trench.

3.03 SHEETING AND BRACING

A. Furnish, put in place and maintain sheeting and bracing required by Federal, State or local safety requirements to support the sides of the excavation and prevent loss of ground which could endanger personnel, damage or delay the work or endanger adjacent structures. If the CO/COTR is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

B. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.

1. When installing rigid pipe (R.C., V.C., A.C., etc), any portion of the box extending below mid diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.

2. When installing flexible pipe (PVC, etc), trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be recompacted to provide uniform side support for the pipe.

C. Permission will be given to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing and later removal of sheeting.

D. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, by watering or otherwise as directed.

E. No payment will be given for sheeting, bracing, etc, during the progress of the work. No payment will be given for sheeting which has actually been left in the trench for the convenience of the Contractor.

F. Sheeting driven below mid-diameter of any pipe shall remain in place from the driven elevation to at least 1-ft above the top of the pipe.

3.04 TEST PITS

A. Excavation of test pits may be required for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

B. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.05 EXCAVATION BELOW GRADE AND REFILL

A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.

B. If the Contractor excavates below grade through error or for the Contractor's own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the CO/COTR to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.

C. If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth which may work into the screened gravel notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 6-in layer of coarse sand, or a mixture graded from coarse sand to the fine peastone, as approved by the CO/COTR, to form a filter layer preserving the voids in the gravel bed of the pipe. The composition and gradation of gravel shall be approved by the CO/COTR prior to placement. Screened gravel shall then be placed in 6-in layers thoroughly compacted up to the normal grade of the pipe. If directed by the CO/COTR, approved sandy gravel fill shall be used for refill of excavation below grade.

D. Geotextile filter fabric may be substituted for filter layer if approved by the CO/COTR. Filter fabric shall be Mirafi 500X; or equal.

3.06 BACKFILLING

A. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Bedding gravel, as specified for the type of pipe installed, shall be placed up to 1-ft over the pipe.

B. An impervious dam or bulkhead cutoff of clay or other impervious material shall be constructed in the trench as directed, to interrupt the unnatural flow of groundwater after construction is completed. The dam shall be effectively keyed into the trench bottom and sidewalls. Provide at least one clay or other impervious material dam in the pipe bedding between each manhole where directed or every 300-ft, whichever is less.

C. Where the pipes are laid cross-country, the remainder of the trench shall be filled with common fill material in layers not to exceed 3-ft and mounded 6-in above the existing grade or as directed. Where a loam or gravel surface exists prior to cross-country excavations, it shall be removed, conserved and replaced to the full original depth as part of the work under the pipe

items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.

D. Where the pipes are laid in streets, the remainder of the trench up to a depth of 1-ft (20-in for State Highways below the bottom of the specified permanent paving shall be backfilled with common fill material in layers not to exceed 1-ft and thoroughly compacted. The subbase layer for paving shall be of 3/4-in crushed stone base course as approved by the CO/COTR thoroughly compacted in 6-in layers.

E. To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until selected material or screened gravel has been placed and compacted to a level 1-ft over the pipe.

F. Backfill shall be brought up evenly on all sides. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping, to 92 percent compaction. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.

G. Water jetting or puddling may be used unless the refill contains too great a proportion of clay or loam to permit satisfactory drying. Water jetting shall consist of using a suitable length of pipe at least 1-1/4-in in diameter fitted with quick acting valve and sufficient hose to connect to hydrant or pump having adequate pressure and capacity. The full depth of backfill shall be thoroughly inundated by thrusting the pipe into the fill at frequent intervals with the valve open until all slumping ceases. Where backfill is compacted by puddling, it shall be done by depositing in water. Water for jetting or puddling may be obtained from City of Libby with proper approval in advance of the work. Water may be furnished from these hydrants if reasonable care is exercised in its use and when approved by the Water Department.

H. If water restrictions are in force, obtain water elsewhere, or compact the backfill by other approved methods at no additional cost to this Contract.

I. Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least 20 lbs. The material being spread and compacted in layers not over 6-in thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.

J. Backfill around structures shall be selected common fill material, may be compacted by puddling where approved by the CO/COTR. All backfill shall be compacted, especially under and over pipes connected to the structures.

K. Subject to the approval of the CO/COTR, fragments of ledge and boulders smaller than 6-in may be used in trench backfill providing that the quantity in the opinion of the CO/COTR, is not excessive. Rock fragments shall not be placed until the pipe has at least 2-ft of earth cover. Small stones and rocks shall be placed in thin layers alternating with earth to ensure that all voids are completely filled. Fill shall not be dropped into the trench in a manner to endanger the pipe.

L. Bituminous paving shall not be placed in backfilling unless specifically permitted, in which case it shall be broken up as directed by the CO/COTR. Frozen material shall not be used under any circumstances.

M. All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

3.07 RESTORING TRENCH SURFACE

A. Where the trench occurs adjacent to paved streets, paved parking areas, concrete slabs on grade, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.

B. In and adjacent to streets, the top 12-in layer (20-in in State Highways) of trench backfill shall consist of compacted bank-run gravel approved by the CO/COTR. Should the Contractor wish to use material excavated from the trench as gravel subbase for pavement replacement, the Contractor, at his/her own expense, have samples of the material tested by an independent testing laboratory at intervals not to exceed 500-ft, in order to establish its compliance with the specifications. Only material which has been tested and approved by the CO/COTR shall be allowed to be incorporated into the work.

C. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored to a condition at least equal to that existing before work began.

D. In sections where the pipeline passes through grassed areas, and at the Contractor's own expense, remove and replace the sod, or loam and seed the surface to the satisfaction of the CO/COTR.

END OF SECTION

SECTION 03301

CONCRETE AND REINFORCING STEEL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all concrete work complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Earthwork requirements are shown on the Drawings. Trenching, backfilling and compaction requirements are provided in Section 02221.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data. Submittals shall include the following:

1. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water cementitious ratio, type and manufacturer of cement.

2. Placing drawings and bar bending details in conformity with the recommendations of ACI 315.

3. Technical data on all materials and components.

4. Material Safety Data Sheets (MSDS) for all concrete admixtures and curing agents.

5. A concrete placement plan showing proposed locations of construction joints and a description of the contractor's proposed methods of concrete placement. The plan shall address cold or hot weather concrete procedures as appropriate. The plan shall describe the work force and equipment the contractor plans to use to place, screed and finish each high early strength concrete placement.

B. Test Reports

1. Sieve analysis of fine and coarse aggregates.

2. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water cementitious ratio, type and manufacturer of cement, and either a. or b. below.

a. Standard deviation data for each proposed concrete mix based on statistical records.

b. Water cementitious ratio curve for each proposed concrete mix based on laboratory tests. Give average cylinder strength test results at 7 days for laboratory concrete mix designs. Provide results of 3, 7 and 28 day tests if available.

C. Certifications

1. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain for Concrete Reinforcement.

3. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

4. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

5. ASTM C33 - Standard Specification for Concrete Aggregates.

6. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

7. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete

8. ASTM C150 - Standard Specification for Portland Cement

9. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

10. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

11. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

12. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

13. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

14. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

2. ACI 301 - Standard Specification for Structural Concrete.

3. ACI 305R - Hot Weather Concreting.

4. ACI 306R - Cold Weather Concreting.

5. ACI 315 - Details and Detailing of Concrete Reinforcement.

6. ACI 318 - Building Code Requirements for Structural Concrete.

C. Concrete Reinforcing Steel Institute (CRSI)

1. MSP - Manual of Standard Practice

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the CO/COTR may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.

B. Reinforced concrete shall comply with ACI 318.

C. All testing and inspection services required, unless otherwise specified, shall be provided and paid for by the Government. Testing necessary to establish the concrete mixes shall be performed by and at the expense of the Contractor. Methods of testing shall comply with the latest applicable ASTM standards.

1.06 DELIVERY, STORAGE AND HANDLING

A. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as shown on the submitted placing drawings. Reinforcing steel shall be free from mill scale, loose rust, dirt, grease, or other foreign matter. Store off the ground and protect from moisture, dirt, oil, or other injurious contaminants.

B. Products shall be stored in conformity with the manufacturer's recommendations.

C. Sand, aggregates and cement shall be stored or stockpiled in conformity with the recommendations of ACI 301.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

C. Materials shall comply with this Section and any applicable State or local requirements.

2.02 MATERIALS

A. Cement shall be domestic portland cement conforming to ASTM C150. The allowable types of cement for each concrete class are shown in Table 1. Air entraining cements shall not be used.

B. Fine aggregate shall be washed inert natural sand conforming to the requirements of ASTM C33.

C. Coarse aggregate shall be a well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, size 67. Limits of Deleterious Substances and Physical Property Requirements shall be as recommended for severe weathering regions.

D. Water shall be potable, clean and free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances.

E. Concrete admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures [and shall be suitable for use in contact with potable water after 30 days of concrete curing].

1. Air entraining admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

2. Water reducing admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

3. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the CO/COTR. When allowed, the admixtures shall be retarding or accelerating water reducing admixtures.

F. Reinforcing steel bars shall be deformed, intermediate grade, steel conforming to ASTM A615 Grade 60.

G. Welded steel wire fabric shall conform to ASTM A185.

H. Tie wires for reinforcing steel shall be 16 gauge or heavier, black annealed wire.

I. Precast concrete block bar supports shall conform to CRSI - Manual of Standard Practice (MSP) for Precast Concrete Bar Supports.

J. Premolded joint filler shall be self-expanding cork, conforming to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.

K. Sealant shall a traffic-grade, polyurethane, elastomeric sealant conforming to ASTM C920 and shall be Sikaflex 2c NS TG by Sika Corporation, Lyndhurst, NJ, or equal.

2.03 MIXES

A. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

B. The design of each mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, be developed by independent testing laboratory acceptable to the CO/COTR engaged by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. Acceptance of mixes based on laboratory tests shall be based on strengths greater than the specified design strengths specified in Table 1. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strength. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.

C. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the compression strength requirements in conformity with the above paragraph.

D. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.

E. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1.

F. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

TABLE 1

| Class | Design Strength (1) | Cement. ASTM C150 | Cement Content (2) | W/C (3) | WR (4) | Slump Range Inches |
|---|---|---|---|---|---|---|
| D | 4000 | Type III | 560 | 0.44 max. | Yes | 3-5 |

All concrete classes shall have 3.5 to 5 percent air entrainment.

NOTES:

(1) Minimum compressive strength at 7 days
(2) Minimum cement content in lbs/cu yd
(3) W/C is Water Cement ratio
(4) WR is water reducing admixture

## 2.04 MEASURING, BATCHING, MIXING AND TRANSPORTING CONCRETE

A. Measuring, batching, mixing and transporting concrete shall conform to ASTM C94 and the requirements herein, or as otherwise approved in writing by the CO/COTR.

B. Ready-mixed concrete, whether produced by a concrete supplier or the Contractor shall conform to the requirements above. No hand mixing will be permitted.

C. Admixtures shall be dispensed into the batch in conformity with the recommendations of the manufacturer of the admixtures.

D. Concrete shall be mixed until there is uniform distribution of the materials and shall be discharged completely before the mixer is recharged. The mixer shall be rotated at a speed recommended by the mixer manufacturer and mixing shall be continued for at least 1-1/2 minutes after all the materials are in the mixer. Concrete shall be placed within 1-1/2 hours of the time at which water was first added, otherwise it shall be rejected. Concrete which has been remixed or retempered, or to which an excess amount of water has been added, shall also be rejected.

## 2.05 FORMS

A. Forms shall be free from roughness and imperfections, substantially watertight and adequately braced and tied to prevent motion when concrete is placed. No wooden spreaders will be allowed in the concrete.

B. Wire ties will not be allowed. Metal ties or anchorages which are necessary within the forms shall be so constructed that the metal work can be removed for a depth of at least 1-in from the surface of the concrete without injury to such surface by spalling or otherwise. Forms shall be thoroughly cleaned before using and shall be treated with oil, or other approved material.

C. All exposed edges of the finished concrete shall be chamfered 3/4-in.

# PART 3 EXECUTION

## 3.01 REINFORCING STEEL

A. Reinforcing steel shall be accurately fabricated to the dimensions shown. Bars shall be bent around a revolving collar having a diameter of not less than that recommended in ACI 318. All bars shall be bent cold.

B. Unless otherwise shown, splices in reinforcing steel shall be lapped in conformity with ACI 318 but not less than 24 diameters. All bar splices shall be staggered wherever possible. When splicing bars of different diameters, the length of lap is based on the larger bar.

C. Splices in welded wire fabric shall be lapped not less than 1-1/2 courses or 12-in, whichever is greater. Wire fabric splices shall be tied together with wire ties spaced no more than 24-in on center.

D. Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt and other coatings, including ice, that reduce or destroy bond. Where there is a delay in depositing concrete after the reinforcement is in place. Bars shall be reinspected and cleaned when necessary.

E. Reinforcement which is to be exposed for a considerable length of time after being placed shall be given a heavy coat of cement grout.

F. In no case shall any reinforcing steel be covered with concrete until the amount and position of the reinforcements have been checked and permission given to proceed by the CO/COTR.

3.02 INSPECTION AND COORDINATION

A. The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the CO/COTR at all times. The Contractor shall advise the CO/COTR of his/her readiness to proceed at least 24 hours prior to each concrete placement. The CO/COTR will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel, and the alignment, cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the CO/COTR.

3.03 CONCRETE APPEARANCE

A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected.

B. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete when viewed in good lighting from 10-ft away shall be pleasing in appearance and at 20-ft shall show no visible defects.

3.04 PLACING AND COMPACTING

A. No concrete shall be placed until forms, condition of subgrade and method of placement have been approved by the CO/COTR. Before depositing concrete, all debris, foreign matter, dirt and water shall be removed from the forms. The contact surface between concrete previously placed and new concrete shall be cleaned and brushed with cement paste. Concrete, except as indicated on the Drawings, shall not be placed in water or submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh concrete within 4 days after its placing.

B. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Pumping of concrete will be permitted when an approved design mix and aggregate sizes, suitable for pumping, are used. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials. If the section cannot be placed continuously, place

construction joints as specified or as approved. Place concrete for walls using tremie tubes in 12 to 24-in lifts, keeping the surface horizontal. Do not drop concrete more than 4-ft.

C. High frequency mechanical vibrators shall be used to the extent necessary to obtain proper consolidation of the concrete, but not to move or transport concrete in the forms. Care shall be taken to avoid segregation of aggregates by excess vibration. Vibration shall continue until the frequency returns to normal, trapped air ceases to rise and the surface appears liquefied, flattened and glistening. Concrete adjacent to forms and around pipe stubs shall be carefully spaded or rodded.

3.05 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. All concrete shall be cured in conformity with ACI 301. Concrete shall be water cured. Water curing shall be by ponding, by continuous sprinkling or by covering with continuously saturated burlap. Other concrete shall be cured by either water curing, sheet material curing or liquid membrane curing compound except that liquid membrane curing compound shall not be used on any concrete surface where additional concrete is to be placed or where the concrete surface is to be coated or painted.

C. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting:

1. "Cold weather" is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40 degrees F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Cold weather concreting shall conform to ACI 306.1 and the additional requirements specified herein. Temperatures at the concrete placement shall be recorded at 12 hour intervals (minimum).

3. Discuss a cold weather work plan with the Engineer. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.

4. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 350 degree-days of curing.

a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (eg: 5 days at an average 70 degrees F = 350 degree-days).

b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

5. Salt, manure or other chemicals shall not be used for protection.

6. The protection period for concrete being water cured shall not be terminated during cold weather until at least 24 hours after water curing has been terminated.

E. Hot Weather Concreting

1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation estimated in accordance with ACI 305R, approaching or exceeding 0.2 lbs/sq ft/hr).

2. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R and the additional requirements specified herein.

a. Temperature of concrete being placed shall not exceed 90 degrees F and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints.

b. All necessary precautions shall be taken to promptly deliver, to promptly place the concrete upon its arrival at the job and to provide vibration immediately after placement.

c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material.

3. Discuss with the Engineer a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the Engineer.

F. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints. Immediately cover plastic concrete with sheet material during hot weather.

3.06 FIELD TESTS

A. Sets of four field control cylinder specimens will be taken by the CO/COTR during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set, nor less than one set for each 150 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. One cylinder shall be broken at 3 days, one cylinder at 7 days and two cylinders shall be reserved for additional testing at 28 days or as determined by the CO/COTR. When the average 7 day compressive strength of the cylinders in any set falls below the specified compressive strength or below proportional minimum 7 day strengths (where proper relation

between 7 and 28 day strengths have been established by tests); the CO/COTR may reject the concrete represented by the set of cylinders, may require modification of the concrete and/or require modification of the proportions, water content, or temperature conditions of the design mix to achieve the required strengths.

B. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through his/her operations and furnishing material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Government.

C. Slump tests will be made in the field by the CO/COTR in conformity with ASTM C143.

D. Tests for air content shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173.

3.07 STRIPPING AND FINISHING CONCRETE

A. Forms shall not be stripped before the concrete has attained a strength of at least 30 percent of the specified design strength, unless otherwise approved by the Engineer. This is equivalent to approximately "100 day-degrees" of moist curing.

B. Care shall be exercised to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or doing any other work adjacent thereto.

C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. As soon as forms have been stripped, form ties, if employed, shall be removed, and the recess filled to insure complete watertightness. Any defects in the surface of the walls shall be chipped out and repaired in a workmanlike manner. Defective concrete where it occurs shall be cut to a minimum depth of 1-in, thoroughly roughened and neat cement brushed in. The hole shall then be filled with mortar in the proportion of 1 part cement and 2-1/2 parts sand with a minimum of water. Mortar for filling form tie recesses shall be mixed to a slightly damp consistency (just short of "balling"), pressed into the recess until dense, and troweled smooth. Mortar in larger patches shall be applied and allowed to assume a partial set following which it shall be struck off flush with the adjoining surface. Patches shall be kept moist for several days to assure proper curing.

E. Top surface of slabs shall be screeded to the established grades and shall be a true plane with a tolerance of 1/8-in when checked with a 10-ft straightedge. The surface shall be finished to give a smooth, hard, even surface free from high or low spots or other defects. Concrete shall be given a broom finish. Failure to meet the condition shall be cause for removal, grinding, or other approved correction.

F. Concrete Finishes

1. Entire floor area shall receive a steel trowel finish.

2. Steel Trowel Finish. Finish by screeding and floating with straightedges to bring the surfaces to the elevations indicated. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated

to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on the wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks. Trowel the surface again for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling.

3. Power Machine Finish. In lieu of hand steel trowel finishing, an approved power machine for finishing concrete floors and slabs may be used in accordance with the directions of the machine manufacturer and as approved by the CO/COTR The use of a power machine will not be allowed when the concrete has not attained the necessary set to allow finishing without introducing high and low spots in the slab. Hand steel trowel the areas of slabs not accessible to power equipment. A final steel troweling shall be done by hand over all areas.

3.08 SCHEDULE

A. The following (Table 2) are the general applications for the various concrete design strengths to be used:

TABLE 2

| Class | Design Strength (psi) | Description |
|---|---|---|
| D | 4,000 | Slabs-on-grade and all structural concrete |

END OF SECTION

SECTION 16020

ELECTRICAL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install complete and make operational, electrical systems as specified and as shown on the Drawings. The work specified in this Section is to be completed as part of the Government's time critical asbestos removal project in Libby, Montana, by the Government's removal contractor.

B. The work shall include the following:

1. Confirm existing electrical service from the Power Company.

2. Disconnect the electrical connection to the existing bathroom (temporary trailer facilities).

3. Conduit, wire and field connections for all motors and control devices, and electrical equipment furnished under other Divisions.

4. Power wiring for all heating and ventilating equipment furnished under other Divisions, including power wiring for 120 Volt unit heater motors.

5. Power wiring for the sewage pump.

6. Furnishing and installing high level alarm float switch and indicating light for septic tank.

C. Final locations of all electrical system components shall be coordinated with the CO/COTR and the property owner.

D. The property owner will be responsible for hiring a licensed electrical contractor to complete conduit installations, wiring, furnish and install electrical service and panelboards, and all other electrical work not included in this Section in conjunction with the construction of the bathroom proposed for the property.

1.02 RELATED WORK

A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is included in Division 2.

B. Refer to the Architectural floor plans for room and building dimensions and exact locations of equipment other than electrical equipment

1.03 SUBMITTALS

A. Submit shop drawings for equipment, materials, and other items furnished under this Section.

B. The CO/COTR's check shall be for conformance with the design concept of the project and compliance with the Specifications and Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specification and Drawings.

C. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

E. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."

1.04 CONTRACT PERFORMANCE REQUIREMENTS

A. Electric equipment, materials and installation shall comply with the latest edition of the National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. National Fire Protection Association (NFPA)
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. Insulated Cable Engineers Association (ICEA)
7. Instrument Society of America (ISA)
8. Underwriters Laboratories (UL)
9. Factory Mutual (FM)
10. National Electrical Testing Association (NETA)

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 ENCLOSURE TYPES

A. Unless otherwise specified electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, non-process indoor above grade locations.
2. NEMA 4 for outdoor locations and anything outside the bathroom.

1.06 SERVICE AND METERING

A. The power company serving this project is Flathead Electrical Cooperative (FEC). Service will be obtained from an existing 240V, single phase distribution panel. Voltage to be confirmed by FEC.

1.07 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.08 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 16 and repair or replace all defective work and equipment.

B. The following minimum tests and settings shall be performed..

1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, and equipment for proper operation.

2. Check the full load current draw of each motor. Check ampere rating of thermal overloads for motors. If incorrect thermal overloads are installed replace same with the correct size overload.

3. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.

C. Furnish a typewritten report of all test results and final "As-Left" settings upon completion of testing.

1.09 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of project contract drawings, hereinafter called the "record drawings."

B. Record drawings shall accurately show the installed condition of the following items:

1. Raceways and pullboxes.

2. Conductor sizes and conduit fills.

3. Panel Schedule(s).

4. Lighting Fixture Schedule(s).

5. Lighting fixture, receptacle and switch outlet locations.

6. Underground raceway and duct bank routing.

1.10 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new.

B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

1.11 EQUIPMENT IDENTIFICATION

A. Identify equipment (disconnect switches, separately mounted motor starters, etc) furnished under Division 16 with the name of the equipment it serves.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

1.12 INTERPRETATION OF DRAWINGS

A. Unless specifically stated to the contrary, the Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner. Unless otherwise indicated install branch circuit conduits exposed in process/industrial type spaces and concealed in finished spaces.

C. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

D. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the CO/COTR during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the CO/COTR and furnish all labor and materials necessary to complete the work in an approved manner.

E. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.

F. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the CO/COTR for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

G. It is the intent of these Specifications that the Electrical Systems shall be suitable in every way for the service required. All materials and all work that may be implied as being incidental to the work of this Section shall be furnished at no additional cost to the Government.

H. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.

## PART 2 PRODUCTS

### 2.01 CONDUITS AND FITTING

A. Rigid Steel Conduit

1. Rigid steel conduit interior and exterior shall be hot-dipped galvanized and be as manufactured by the Allied Tube and Conduit Corp.; Wheatland Tube Co.; Triangle PWC Inc. or equal.

B. Rigid Nonmetallic Conduit

1. PVC conduit shall be rigid polyvinyl chloride schedule 40 and 80 as manufactured by Carlon; An Indian Head Co.; Kraloy Products Co., Inc.; Highland Plastics Inc. or equal.

C. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.

2. Fittings used with liquidtight flexible metal conduit shall be of the screw-in type as manufactured by the Thomas & Betts Co.; Crouse-Hinds Co. or equal.

D. Boxes and Fittings

1. Pressed steel switch and outlet boxes shall be hot-dipped galvanized as manufactured by the Raco Manufacturing Co.; Adalet Co.; O.Z. Manufacturing Co. or equal.

2. For use in NEMA 1 areas, terminal boxes, junction boxes, pull boxes etc, shall be galvanized sheet steel with continuously welded seams. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amp., 600 Volt. Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; Keystone/Rees, Inc. or equal.

3. NEMA 4 terminal boxes, junction boxes, pull boxes, etc, shall be sheet stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amp, 600 Volt. Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; Keystone/Rees, Inc. or equal.

E. Wall and Floor Slab Opening Seals

1. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp.; Pro Set Systems; Neer Mfg. Co.; Specified Technologies, Inc. or equal.

F. Cold Galvanizing Compound

1. Cold galvanizing compound shall be as manufactured by ZRC Products Company, a division of Norfolk Corp. or equal.

2.02 WIRE, CABLE AND ACCESSORIES

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

D. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC Type THHN/THWN as manufactured by Okonite Co.; Southwire Co.; Pirelli Corp., or equal.

E. Wire for control, status and alarm circuits shall be No.14 AWG NEC type THHN/THWN, stranded as manufactured by the Okonite Co.; Carol Cable Co. Inc. West; Pirelli Cable Corp. or equal.

F. Multi-conductor control and power cables shall have stranded conductors with type THHN/THWN insulated, nylon conductor covering, and an overall PVC jacket covering the individual wires. Cable shall be TC rated meeting UL 1277 and IEEE 383 Standards. Cable

shall be flame resistant, nonpropagating and suitable for installation in a Class I, Division II hazardous location and for direct burial in earth. Power and control cables shall be furnished with a green ground conductor. Power cables shall be furnished with a white neutral conductor where required to serve phase to neutral loads. Cable shall be as manufactured by the Okonite Co.; Southwire Co.; General Cable Co., or equal.

G. Wire for process instrumentation signals (i.e. 1-5 VDC, 4-20 mA), R.T.D., potentiometer and similar signals shall be:

1. Single pair cable:

| | |
|---|---|
| Conductors: | 2- No.16 stranded and twisted on 2-in lay |
| Insulation: | PVC with 300 Volt, 105 degree C rating |
| Shield: | 100 percent mylar tape with drain wire |
| Jacket: | PVC with UL Subject 13, UL 1581, and manufacturers identification |
| Max overall diameter: | 0.262-in |
| Misc: | UL listed for underground wet location use |
| Manufacturers: | Belden No. 1030 or equal |

H. Splices for power wiring shall be compression type connectors insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem; Ideal Industries; 3M Co. or equal.

I. Termination connectors for control wiring shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

J. Splices for control wiring shall be insulated compression type connectors of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

K. Wire markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co.; 3M Co. or equal.

L. Direct buried cable warning tape shall be 6-in wide, red polyethylene not less than 0.0035-in thick. Tape shall be W.H. Brady Co., Cat. No. 91296 or equal.

## 2.03 WIRING DEVICES

A. Wall switches shall be heavy duty, specification grade, toggle action, flush mounting quiet type. All switches shall conform to the latest revision of Federal Specification WS 896. Wall switches shall be of the following types and manufacturer:

1. Single pole, 20 Amp, 120/277 Volt - Arrow-Hart, Catalog No. 1991, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc. or equal.

2. Double pole, 20 Amp, 120/277 Volt - Arrow-Hart, Catalog No. 1992, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc. or equal.

B. Receptacles shall be heavy duty, specification grade of the following types and manufacturer or equal. Receptacles shall conform to Federal Specification WC596-F.

1. Duplex, 20 Amp, 125 Volt, 2P, 3W; Arrow-Hart, Catalog No. 5362, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc.

2. Weatherproof/corrosion resistant duplex, 20 Amp, 125 Volt, 2P, 3W, with cover; Crouse-Hinds Co., Catalog No. WLRD-5-20 or equal by Appleton Electric.

3. Ground fault interrupter, duplex, 20 Amp, 125 Volt, 2P, 3W, GFCI feed thru type with "test" and "reset" buttons. Arrow-Hart, Catalog No. GF5342 or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc. or equal.

C. Device Plates

1. Plates for indoor surface mounted device boxes shall be cast metal of the same material as the box, Crouse-Hinds, No. DS23G and DS32G, or equal.

2. Device plates for switches mounted outdoors or indicated as weatherproof shall be gasketed, cast aluminum with provisions for padlocking switches "On" and "Off," Crouse Hinds, No. DS185, or equal.

3. Weatherproof, gasketed cover for GFI receptacle mounted in a FS/FD box shall be Arrow-Hart, Catalog No. 4501-FS or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc. or equal.

## 2.04 MISCELLANEOUS EQUIPMENT

A. Manual Motor Starters

1. Manual starters shall be suitable for the voltage and number of phase shown on the Drawings and shall be non-reversing, reversing or two speed type as shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings. Manual starters shall have motor overload protection in each phase.

2. Manual motor starters shall be as manufactured by the Square D Co. or equal.

B. Circuit Breakers

1. Provide thermal magnetic circuit breaker in NEMA Type 12 Enclosure with externally operated handle. Circuit breakers shall be fully rated for 22,000 Amps RMS symmetrical.

C. Polyethylene Warning Tape

1. Warning tape shall be red polyethylene film, 6-in minimum width.

2. Warning tape shall be W.H. Brady Co., Catalog No. 91296 or equal.

## 2.05 PANELBOARDS

A. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. 120/240 Volt, single phase, 3 Wire panelboards shall be Type AQ as manufactured by the General Electric Company; Type NQOD as manufactured by Square D Co.; Type Pow-R-Line C as manufactured by Cutler-Hammer, or equal.

D. NEMA 4 and 12 panelboards shall be type DVP or DHP as required by voltage application; manufactured by the Crouse-Hinds Company or equal.

E. Rating

1. All panelboards shall be rated for the intended voltage.

2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

F. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.

4. Equipment ground bars shall be furnished.

G. Circuit Breakers

1. Panelboards shall be equipped with circuit breakers.

2. Circuit breakers shall be molded case, bolt-in type.

3. Each circuit breaker used in 120/240 Volt panelboards shall have an interrupting capacity of not less than 22,000 amperes, RMS symmetrical.

4. Circuit breakers shall be as manufactured by the panelboard manufacturer.

2.06 UNDERGROUND SYSTEM

A. Excavation and backfilling, including gravel and sand bedding, are included in Division 2.

B. Concrete and reinforcing steel are included in Division 3.

C. Raceways shall be polyvinyl chloride conduit encased in concrete, except that rigid steel conduit shall be used for 600 Volt shielded wire and data highway wiring.

D. Handholes shall be precast concrete, heavy-duty type, designed for a Class H-20 wheel load and conform to ASTM C478. Precast units shall be as manufactured by Chase Precast Corp.; American Precast Co. or equal and constructed to dimensions as shown on the Drawings.

E. Handhole frames and covers shall be cast iron, heavy duty type for Class H-20 wheel loading.

2.07 GROUNDING

A. Ground rods shall be 3/4-in by 10-ft copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 0.25 mm. Ground rods shall be Copperweld or equal.

B. Grounding conduit hubs shall be malleable iron type similar to Thomas & Betts Co.; Cat No. 3940 (3/4-in conduit size) by Burndy; O.Z. Gedney Co. or equal, and of the correct size for the conduit.

C. Buried grounding connections shall be by Cadweld process, or equal exothermic welding system.

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the CO/COTR may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration and slots.

3.02 CUTTING AND PATCHING

A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified on Drawings. Sawcut concrete and masonry prior to breaking out sections.

B. Core drill holes in concrete floors and walls as required.

C. Install work at such time as to require the minimum amount of cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members.

E. Cut opening only large enough to allow easy installation of the conduit.

F. Patching to be of the same kind and quality of material as was removed.

G. The completed patching work shall restore the surface to its original appearance or better.

H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

I. Remove rubble and excess patching materials from the premises.

J. When existing conduits are cut at the floor line of wall line, they shall be filled with grout of suitable patching material.

3.03 INSTALLATION

A. Any work not installed according to the Drawings and Specification shall be subject to change as directed by the CO/COTR. No extra compensation will be allowed for making these changes.

B. Electrical equipment shall be protected at all times against mechanical injury or damage by water. Electrical equipment shall not be stored outdoors. Electrical equipment shall be stored in dry permanent shelters. Do not install electrical equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and tested as directed by the CO/COTR, or shall be replaced at no additional cost at the CO/COTR's discretion.

C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the CO/COTR's discretion.

D. Coordinate the conduit installation with the CO/COTR, property owner, other trades and the actual supplied equipment.

E Install each circuit in separate conduit.

F. Unless otherwise approved by the CO/COTR, conduit installed interior to the building shall be installed exposed; conduit installed exterior to the building shall be concealed.

G. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

H. Exact locations of electrical equipment shall be determined by the Contractor, CO/COTR, and property owner and approved by the CO/COTR during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the CO/COTR and furnish all labor and materials necessary to complete the work in an approved manner.

3.04 BOXES AND FITTINGS

A. Except where otherwise specified, all wiring shall be in rigid steel conduit.

B. Rigid steel conduit shall be used for elbows and risers to equipiment.

C. All boxes shall be metal.

D. Exposed switch, receptacle and lighting outlet boxes and condulet fittings shall be cast or malleable iron, except that cast aluminum shall be used with aluminum conduit.

E. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel.

F. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.

G. Conduit wall seals shall be used where underground conduits penetrate walls.

H. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather.

I. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required or directed.

J. No wire shall be pulled until the conduit system is complete in all details.

K. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction.

L. All conduits shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.

M. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.

N. Conduit terminating in NEMA 4 and 12 enclosures shall be terminated with Myers type conduit hubs.

O. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.

P. Conduits shall be installed using threaded fittings.

Q. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke.

R. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

S. All conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits.

T. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of N.E.C. Article 370.

U. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed.

V. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc for a rigid installation.

3.05 WIRE, CABLE AND ACCESSORIES

A. Uniquely identify all wires, cables and each conductor of multi- conductor cables (except lighting and receptacle wiring) at each end with wire and cable markers.

B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

C. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, and other accessible intermediate locations as well as at each termination.

D. The following coding shall be used:

| System | Wire | Color |
|---|---|---|
| 240/120 Volts | Neutral | White |
| 1-Phase, 3-Wire | Line 1 | Black |
| | Line 2 | Red |

E. Power conductors: Terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.

F. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.

G. Except where permitted by the CO/COTR no splices will be allowed in manholes, handholes or other below grade located boxes.

H. Instrumentation cables shall be installed in rigid steel raceways as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

I. Terminal blocks shall be provided at all instrument cable junction, and all circuits shall be identified at such junctions.

J. Test all 600 Volt wire insulation with a megohm meter after installation. Make tests at not less than 500V. Submit a written test report of the results to the CO/COTR.

3.06 WIRING DEVICES

A. Switch and receptacles outlets shall be installed flush with the finished wall surfaces in areas with stud frame and gypboard construction, in dry areas with cement block construction or when raceways are concealed.

B. Do not install flush mounted devices in areas designated DAMP, WET or WET/CORROSIVE. Provide surface mounted devices in these areas.

C. Provide weatherproof devices covers in areas designated WET or WET/CORROSIVE.

3.07 PANELBOARDS

A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses.

C. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.

D. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.

E. Install a 1-in by 3-in laminated plastic nameplate with 1/4-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

3.08 UNDERGROUND SYSTEM

A. Install raceways to drain away from buildings.

B. Reinforce raceway banks when conduits pass over newly excavated pipes.

C. The minimum cover for raceway banks shall be 24-in unless otherwise permitted by the CO/COTR.

D. Swab all raceways clean before installing cable.

E. Plug spare raceways and seal them watertight at all manholes, buildings and structures.

F. Seal the ends of raceways and make watertight at all handholes, buildings and structures.

3.09 GROUNDING

A. Run grounding electrode conductors in rigid steel conduits. Bond the protecting conduits to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, dis-assemble them and re-make them with new fittings.

B. Install equipment grounding conductors with all feeders and branch circuits.

C. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus.

D. Ground wire connections to structural steel columns shall be made with long barrel type one-hole heavy duty copper compression lugs, bolted through 1/2-in maximum diameter holes drilled in the column web, with stainless steel hex head cap screws and nuts.

E. Metal conduits stubbed into a motor control center shall be terminated with insulated grounding bushings and connect to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250-95, except that a minimum No. 12 AWG shall be used.

F. Liquid tight flexible metal conduit in sizes 1-1/2-in and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

G. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250-94.

H. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.

I. Lay all underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.

J. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

K. All grounding type receptacles shall be grounded to the outlet boxes with a No. 12 THW green conductor connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.

L. Test the grounding system. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

M. Testing shall be performed before energizing the distribution system.

N. Notify the CO/COTR immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION